CLAIMS

1. An apparatus utilizing a lamp for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin; and

a mechanism for directing photons from said lamp through said waveguide to the patient's skin, said mechanism including a submechanism which inhibits the loss of photon from said apparatus.

2. An apparatus as claimed in claim 1 wherein said mechanism includes a reflector, said submechanism including said reflector and waveguide being sized and shaped so that they fit together with substantially no gap therebetween.

3. An apparatus as claimed in claim 2 including a reflective material substantially sealing any gap between said reflector and waveguide.

4. An apparatus as claimed in claim 1 wherein said mechanism includes a reflector, said reflector being sized and mounted with respect to said lamp so as to minimize the number of reflections for each photon on said reflector.

5. An apparatus as claimed in claim 4 wherein said reflector is small enough and mounted close enough to said lamp to achieve said minimum number of reflections.

6. An apparatus as claimed in claim 4 wherein said reflector is formed on an outer surface of said lamp.

7. An apparatus as claimed in claim 4 including a tube surrounding said lamp, there being a gap between said lamp and tube through which a fluid is flowed to cool the lamp.

8. An apparatus as claimed in claim 7 wherein said reflector is formed on one of an inner and outer surface of said tube.

9. An apparatus as claimed in claim 4 wherein said reflector has a substantially cylindrical shape.

10. An apparatus as claimed in claim 4 wherein said reflector is a scattering reflector.

11. An apparatus as claimed in claim 10 including a mechanism for controlling the wavelengths filtered by said scattering reflector.

12. An apparatus as claimed in claim 4 wherein said reflector is of a material which filters selected wavelengths of light from said lamp impinging thereon.

13. An apparatus as claimed in claim 1 wherein said mechanism includes a reflector, wherein there is a gap between said reflector and said waveguide, and including a second reflector in said gap which in conjunction with said reflector directs substantially all photons from said lamp to said waveguide.

14. An apparatus as claimed in claim 1 including a mechanism for selectively filtering light from said lamp to achieve a desired wavelength spectrum, said mechanism for selectively filtering being included as part of at least one of said lamp, a coating formed on said lamp , a tube surrounding said lamp, a filter device in a gap between said lamp and said tube, a reflector for light from said lamp, the waveguide, and a filter device between said lamp and said waveguide.

15. An apparatus as claimed in claim 14 wherein said mechanism for selectively filtering is included as part of a plurality of the components listed in claim 14.

16. An apparatus as claimed in claim 14 wherein said mechanism for selectively filtering is at least one of an absorption filter, a selectively reflecting filter, and a spectral resonant scatterer.

17. An apparatus as claimed in claim 14 wherein said mechanism includes a multilayer coating.

18. An apparatus as claimed in claim 1 wherein said waveguide is of a length selected to enhance uniformity of the light output from said lamp.

19. An apparatus as claimed in claim 18 wherein the uniformity of light output from said waveguide has resonances as a function of waveguide length, and wherein the length of said waveguide is equal to one of the resonant lengths.

20. An apparatus as claimed in claim 18 wherein said waveguide has a width and depth at an end of the waveguide adjacent the lamp, and wherein the length of the waveguide is much greater then the smaller of said width and depth.

21. An apparatus as claimed in claim 1 including a mechanism for controlling the angular spectrum of photons within the patients skin.

22. An apparatus as claimed in claim 21 including a gap between the lamp and said waveguide which gap is filled with a substance having a selected index of refraction.

23. An apparatus as claimed in claim 22 wherein the length of said gap is minimized.

24. An apparatus as claimed in claim 22 wherein said gap is filled with air.

25. An apparatus as claimed in claim 1 wherein said waveguide has a larger area at a light receiving surface then at a light output surface, and wherein said waveguide has curved sides between said surfaces.

26. An apparatus as claimed in claim 1 wherein said waveguide has a plurality of cuts formed therethrough, said cuts being adapted to have a coolant fluid flow therethrough.

27. An apparatus as claimed in claim 1 wherein said waveguide has a surface in contact with the patients skin which is patterned to control the delivery of photons to the patient's skin.

28. An apparatus as claimed in claim 1 wherein said waveguide has a surface in contact with the patient's skin which is concave.

29. An apparatus as claimed in claim 28 where said waveguide has one of a concave skin contacting surface and a rim surrounding the waveguide with a concave edge.

30. An apparatus as claimed in claim 28 wherein the depth of said concave surface is selected to, in conjunction with pressure applied to the apparatus, control the depth of blood vessels treated by the apparatus.

31. An apparatus as claimed in claim 30 including a mechanism for detecting the depth of blood vessels in which blood flow is restricted by application of said concave surface under pressure to the patient's skin, said mechanism permitting pressure to be controlled to permit treatment of vessels at a desired depth.

32. An apparatus as claimed in claim 1 wherein said waveguide has a skin contacting surface shaped to permit the application of selective pressure to the patient's skin and to thereby control the depth at which treatment is performed.

33. An apparatus as claimed in claim 32 wherein said apparatus is being used to treat blood vessels, and including a mechanism for detecting the depth of blood vessels in which blood flow is restricted by application of said surface under pressure to the patient's skin and to thereby control the depth at which treatment is performed.

34. An apparatus as claimed in claim 1 wherein said waveguide is at least in part one of a lasing and a superluminescent waveguide.

35. An apparatus as claimed in claim 34 wherein said waveguide includes a lasing waveguide inside an optical waveguide.

36. An apparatus as claimed in claim 1 wherein said waveguide has a skin contacting surface, and including a mechanism which delivers a cooling spray to both the patient's skin and said skin contacting surface just prior to said surface making contact with the skin.

37. An apparatus as claimed in claim 36 wherein said waveguide includes a lower portion adjacent the patient's skin of a material which is a good conductor of heat and an upper portion of a material which is not a good conductor of heat, the thickness of said lower portion controlling the depth of cooling in the patient's skin.

38. An apparatus as claimed in claim 36 wherein said mechanism includes a detector indicating when the apparatus is within a predetermined distance of the patient's skin, said cooling spray being activated in response to said detector.

39. An apparatus as claimed in claim 1 including a rearward facing light output channel from said waveguide which leads to a backscatter detector, said channel being at an angle α to a perpendicular to the skin which assures that only backscattered light reaches the detector.

40. An apparatus as claimed in claim 1 wherein said lamp is driven with a power profile which is one of the power profiles 44, 45 and 46 of Fig. 11.

41. An apparatus as claimed in claim 1 wherein said waveguide is formed as a unitary component with said lamp passing through an opening formed therein.

42. A method for utilizing a lamp for performing hair removal utilizing the parameters of table 1.

43. A method for utilizing a lamp for performing treatment of vascular lesions utilizing the parameters of table 2, 3 and 4.

44. A method for utilizing a lamp for performing skin rejuvenation utilizing the parameters of tables 2 and 6.

45. A method for utilizing a lamp for performing treatment of acne by at least one of killing bacteria, thermolysis of the sebaceous gland and killing spider veins feeding the sebaceous gland.

46. A method of utilizing a lamp for performing treatment of pigmented lesions utilizing the parameters of table 5.

47. An apparatus utilizing a lamp for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin; and

a mechanism for directing photons from said lamp through said waveguide to the patient's skin, said mechanism including a reflector, said reflector being mounted close enough to said lamp and being small enough so as to minimize the number of reflections for each photon on said reflector.

48. An apparatus as claimed in claim 47 wherein said reflector is formed on an outer surface of said lamp.

49. An apparatus as claimed in claim 47 including a tube surrounding said lamp, there being a gap between said lamp and tube through which a fluid is flowed to cool the lamp.

50. An apparatus as claimed in claim 49 wherein said reflector is formed on one of an inside and an outside surface of said tube.

51. An apparatus as claimed in claim 47 wherein said reflector has a substantially cylindrical shape.

52. An apparatus as claimed in claim 47 wherein said reflector is a scattering reflector.

53. An apparatus as claimed in claim 52 including a mechanism for controlling the wavelengths filtered by said scattering reflector.

54. An apparatus as claimed in claim 47 wherein said reflector is of a material which filters selected wavelengths of light from said lamp impinging thereon.

55. An apparatus utilizing a lamp for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin;

a mechanism for directing photons from said lamp through said waveguide to the patient's skin; and

a mechanism for selectively filtering light from said lamp to achieve a desired wavelength spectrum, said mechanism for selectively filtering being included as part of at least one of said lamp, a coating formed on said lamp, a tube surrounding said lamp, a filter device in a gap between said lamp and said tube, a reflector for light from said lamp, the waveguide, and a filter device between said lamp and said waveguide.

56. An apparatus as claimed in claim 55 wherein said mechanism for selectively filtering is included as part of a plurality of the components listed in claim 53.

57. An apparatus as claimed in claim 55 wherein said mechanism for selectively filtering is at least one of an absorption filter, a selectively reflecting filter, and a spectral resonant scatterer.

58. An apparatus as claimed in claim 55 wherein said mechanism includes a multilayer coating.

59. An apparatus utilizing an optical radiation source for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin; and

a mechanism for directing photons from said source through said waveguide to the patient's skin, said waveguide being of a length selected enhance uniformity of the optical output from said apparatus.

60. An apparatus as claimed in claim 59 wherein the uniformity of optical output from said waveguide has resonances as a function of waveguide length, and wherein the length of said waveguide is equal to one of the resonant lengths.

61. An apparatus as claimed in claim 59 wherein said waveguide has a width and depth at an end of the waveguide adjacent the source, and wherein the length of the waveguide is much greater then the smaller of said width and depth.

62. An apparatus utilizing a lamp for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin;

a mechanism for directing photons from said lamp through said waveguide to the patient's skin; and

a gap between the lamp and said waveguide which gap is filled with a substance having an index of refraction so as to selectively control the angular spectrum of photons within the patient's skin.

63. An apparatus as claimed in claim 62 including a tube spaced from and substantially surrounding said lamp, and wherein said gap is between said tube and said waveguide.

64. An apparatus as claimed in claim 62 wherein the length of said gap is minimized.

65. An apparatus as claimed in claim 62 wherein said gap is filled with air.

66. An apparatus utilizing an optical radiation source for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin, said waveguide having a larger area at a radiation receiving surface then at a radiation output surface, and wherein said waveguide has curved sides between said surfaces; and

a mechanism for directing photons from said source through said waveguide to the patient's skin.

67. An apparatus utilizing an optical radiation source for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin, said waveguide having a larger area at a radiation receiving surface then at a radiation output surface and having side walls between said surfaces;

a reflector on each of said walls to inhibit photon leakage through said walls; and

a mechanism for directing photons from said source through said waveguide to the patient's skin.

68. An apparatus utilizing an optical radiation source for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin, said waveguide having a plurality of cuts formed therethrough, said cuts being adapted to have a coolant fluid flow therethrough; and

a mechanism for directing photons from said source through said waveguide to the patient's skin.

69. An apparatus utilizing an optical radiation source to perform optical dermatology on a patient's skin, said apparatus including:

a waveguide adapted to be in contact with the patients skin, said waveguide having a surface in contact with the patients skin which is patterned to control the delivery of photons to the patient's skin; and

a mechanism for directing photons from said source through said waveguide to the patient's skin.

70. An apparatus utilizing an optical radiation source for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin, said waveguide having a surface in contact with the patient's skin which is concave; and

a mechanism for directing photons from said source through said waveguide to the patient's skin.

71. An apparatus as claimed in claim 70 where said waveguide has one of a concave skin contacting surface and a rim surrounding the waveguide with a concave edge.

72. An apparatus as claimed in claim 70 wherein the depth of said concave surface is selected to, in conjunction with pressure applied to the apparatus, control the depth of blood vessels treated by the apparatus.

73. An apparatus as claimed in claim 72 including a mechanism for detecting the depth of blood vessels in which blood flow is restricted by application of said concave surface under pressure to the patient's skin, said mechanism permitting pressure to be controlled to permit treatment of vessels at a desired depth.

74. An apparatus utilizing an optical radiation source for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin, said waveguide having a skin contacting surface which is adapted for application of selective pressure to the skin to control the depth of treatment; and

a mechanism for directing photons from said source through said waveguide to the patient's skin.

75. An apparatus as claimed in claim 74 wherein said apparatus is being used to treat blood vessels, and including a mechanism for detecting the depth of blood vessels in

which blood flow is restricted by application of said surface under pressure to the patient's skin, said mechanism permitting pressure to be controlled to permit treatment of vessels at a desired depth.

76. An apparatus utilizing an optical radiation source for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin, said waveguide being at least in part one of a lasing and a superluminescent waveguide; and

a mechanism for directing photons from said source through said waveguide to the patient's skin.

77. An apparatus as claimed in claim 76 wherein said waveguide includes a lasing material with mirrors on the end inside an optical waveguide.

78. An apparatus for utilizing an optical radiation source for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with a patient's skin;

at least one of a lasing and a superluminescent material surrounding said lamp;

and a mechanism for directing photons from said source through said waveguide to the patient's skin.

79. An apparatus utilizing an optical radiation source for treatment of a patient's skin, said apparatus including:

a waveguide having a skin contacting surface adapted to be in contact with the patients skin;

a mechanism for directing photons from said lamp through said waveguide to the patient's skin; and

a mechanism which delivers a cooling spray to both the patient's skin and said skin contacting surface just prior to said surface making contact with the skin.

80. An apparatus as claimed in claim 79 wherein said waveguide includes a lower portion adjacent the patient's skin of a material which is a good conductor of heat and an

upper portion of a material which is not a good conductor of heat, the thickness of said lower portion controlling the depth of cooling in the patient's skin.

81. An apparatus as claimed in claim 79 wherein said mechanism includes a detector indicating when the apparatus is within a predetermined distance of the patient's skin, said cooling spray being activated in response to said detector.

82. An apparatus utilizing an optical radiation source for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin;

a mechanism for directing photons from said lamp through said waveguide to the patient's skin; and

a rearward facing light output channel from said waveguide which leads to a backscatter detector, said channel being at an angle α to a perpendicular to the skin which assures that only backscattered light reaches the detector.

83. An apparatus utilizing a lamp for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin;

a mechanism for directing photons from said lamp through said waveguide to the patient's skin; and

a lamp driver which drives said lamp with a power profile which is one of the power profiles 44, 45 and 46 of Fig. 11.

84. An apparatus utilizing a lamp for treatment of a patient's skin, said apparatus including:

a waveguide adapted to be in optical contact with the patients skin, said waveguide being formed as a unitary component with said lamp passing through an opening formed therein, said waveguide including a mechanism for directing photons from said lamp through said waveguide to the patient's skin.

85. A method of using optical radiation to treat a patient's skin, said method including:

applying optical radiation from an optical radiation source through a plate having a first surface in contact with the patient's skin to the skin; and

applying a cooling fluid to a surface of the plate opposite said first surface; the thickness of said plate being selected to control the depth in the patient's skin to which cooling occurs.

86. A method of using optical radiation to treat blood vessels in a patient's skin, the method including:

applying optical radiation from an optical radiation source through a waveguide to the patient's skin, the waveguide having a selectively shaped skin-contacting surface; and

applying a selected pressure to the waveguide, the pressure being sufficient in conjunction with the shape of the waveguide, to substantially remove blood from all blood vessels above vessels on which treatment is to be performed.

87. A method as claimed in claim 86 wherein said waveguide has a concave skin-contacting surface, the depth of the concave surface, in conjunction with the applied pressure controlling the depth of blood vessels being treated.

88. An apparatus for utilizing optical radiation to treat a patient's skin, the apparatus including:

a source of optical radiation; and

a waveguide through which radiation from the source is applied to the patient's skin, the waveguide having scattering properties which are a function of the temperature of the waveguide, whereby the waveguide may automatically control radiation applied to the patient's skin to compensate for changes in patient skin temperature.

89. Apparatus for utilizing an optical radiation from a lamp to treat a patient's skin, the apparatus including:

a mechanism for applying radiation from the lamp to the patient's skin; and

a filtering mechanism which prevent all but at least one band of radiation from the lamp to reach the patients skin, said at least one band being selected such that the temperature at a desired target in the patent's skin to the temperature of the patient's epidermis has a selected value.

90. Apparatus as claimed in claim 89 wherein said selected value is greater than one.

91. Apparatus as claimed in claim 89 wherein there are a plurality of bands passed by said filtering mechanism.